The "Operating Systems" Course as a Base of Students' Learning Activity Parameters Investigation

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Abstract: The paper is devoted to the study of students' learning activity indicators that concern to the time of learning product submission. There were analysed relations of these indicators with parameters of student model in context of pedagogical diagnostics and prognosis. The research was based on the course "Operating Systems" that were studied in traditional blended learning educational process and in distance mode during COVID-19 pandemic. Empirical work gave possibility to analyse correlation between timeliness of completing the learning tasks by students and their educational achievements as well as to analyse the structure of students' time planning at homework. There was shown that students, who completed their educational tasks in time, have good educational achievement according to test results. But we can not say that all students with high educational achievements submitted results of their independent work in time. There was analysed the distribution of students activity during a day. There was shown that working time of students at distance learning is more natural and correspond to business time of day. Some approaches to improve students' competences in learning activity self-management were discussed. Recommendations to improve the educational process have been suggested.

1 INTRODUCTION

1.1 Statement of the Problem

Nowadays, effective educational process is not possible without active use of information and communication technologies. New educational environment puts forward advanced requirements to management of students' learning activity that become more independent. Such management should be grounded on comprehensive models. Theoretical basis of modelling of the open education organizational systems, theory of designing such systems have been expounded from systemic positions in monograph of Bykov (Bykov, 2008). Kiv et al. (Kiv et al., 2019) underline that Information technologies, especially, cloud technologies transform education, and have analysed according to results of the "Cloud Technology in Education" scientific conference modern approaches to managing students' learning activity in university educational environment. Triakina et al. (Triakina et al., 2018) have described the existing E-learning instruments that was designed by the international organizations for self-education and have suggested the ways of this tools implementation into professional training. Vlasenko et al. (Vlasenko et al., 2019) on the base of survey, conducted for teachers, suggested to develop an educational platform – an online environment for collaboration of the experienced professionals, whose joint activities should help in greatly enhancing their professional skills.

Independent work of students become one of the most significant part of modern educational systems. It is the demand of the curriculums and necessity to provide of the dual learning. Therefore, elements of distance learning are widely used in educational process as a form of education and as a form of management of students' independent work. Students' work is realised in specialised learning management environments without teacher's personal presence, and the teacher has no possibility to use traditional forms of pedagogical observation. The teacher needs in special system for management of students' independent learning activity instead of traditional intuitive man-

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agement of learning process.

Learning management systems, for example Moodle, give us various new highly informative tools for pedagogical diagnostics. Management of students' learning activity in information and communication environment should be based on individual pedagogical prognosis for each student with use of an idealised student's achievements model, a model of student's real state and a model of available variants of learning methods (Kolgatin, 2012). The relationship between parameters of this models and indicators that can be directly measured in a learning management system should be studied experimentally and theoretically. The field of interest in this paper is systematicity of student learning activity as a characteristic of student's leaning style and a parameter of student model in learning management system. Indicators of systematicity and its influence on student learning achievements are in the centre of our attention.

1.2 Analysis of Previous Researches

There are many scientific work devoted to students' independent work, its systematicity. But we want to pay attention to experimental data according to this problem. In focus of our interest are time planning and influence of systematicity of students' learning activity on educational achievements. So, Valynuk and Konovalenko (Valynuk and Konovalenko, 2017) pointed on the basis of survey that only 14 % of students prepare to classes systematically, 8 % – occasionally, but 78 % of students work at home only before practical and seminar classes. Klimenko (Klimenko, 2016) believes that systematic learning work of students promotes accumulation of knowledge, mastering in skills. But large amount of short structured tasks leads to obliviousness of educational material, so special work for systematisation should be suggested to students periodically. Lavrentieva et al. (Lavrentieva et al., 2019) draw attention to the necessity of planning independent work with accounting the complexity of its various types and analysing new methods of organization of students' independent study activities together with the use of ICT and tools.

Particularities of students' independent work distribution in time were experimentally studied by Kolgatin et al. (Kolgatin et al., 2020) with use of learning management system Moodle for measuring and collecting data. These results were obtained in traditional in situ educational process with ICT support of out of classes independent work. The authors concluded that students, who suggested their reports on laboratory works in time were more successful in the assessment at low and sufficient levels.

Very useful investigation of time-related behaviours was carried by Boroujeni et al. (Boroujeni et al., 2016). They have analysed three key dimensions of regularity: intra-course, intra-week and intra-day. These authors considered two strategies for participating in MOOCs: regular scheduling of learning activities and adaptive scheduling based on daily work or study schedule.

We can see that researchers consider two aspects of systematicity: according to the educational material structure and according to learning process regularity. The first one correspond to systematicity as knowledge quality, the second – to stability of the learning activity pace. More over, researchers differ systematic and systemic. Systematic work is spread over the days in small portions, which are logically selected and organized by content (Klimenko, 2016). Systematization involves the generalization of knowledge, the establishment of system-forming links to make knowledge to be systemic. There were suggested formulas to process measurements and some criteria were built. There was shown positive correlation between the defined regularity measures and the performance of the student. Students who planed their learning activities in a regular manner had better chances of succeeding in the MOOC.

1.3 Objectives

Despite a number of theoretical and empirical studies in the field of modelling the learning process, there is no integrated model yet. Available models are based on teacher intuition and personal pedagogical observation that complicates using such models for pedagogical prognosis at managing the learning activity in Internet-oriented environments. Great work for specification of models parameters and its indicators, detection of pedagogical criteria influence at efficiency of educational process is very actual. In this way the aim of this paper is to study some indicators of student's time planning in context of their leaning activity systematicity. We try to find correlations between these indicators and at learning results in course "Operating systems". Also we try to look at influence of students independent work management peculiarities on regularity of this work.

2 THEORETICAL FRAMEWORK

In the context of mass education, the teacher cannot pay enough attention to each student to make pedagogical forecast for each student on the basis of own intuition, experience, theoretical and methodological

knowledge. It is necessary to equip the student himself as the subject of the educational process with the skills and appropriate pedagogical forecasting tools for an independent choice of the appropriate variant of educational activity. The teacher should manage this pedagogical diagnostics system and provide the student with necessary help. Design of the computer-based pedagogical diagnostic system requires the development of a learning objectives model, a student psychological and pedagogical model (SPPM) and learning technologies model that would form the basis of this system. These models should be specially structured and should contain a limited number of parameters, which can be directly measured in the educational process.

Let fix our attention at one of this three major models in the system of pedagogical diagnostics – the psychological and pedagogical model of the student (SPPM) (Kolgatin, 2012). SPPM is built on the basis of learning objectives model so that the parameters of the student model reflect the forthcoming to the intended learning goal. The SPPM is to allow comparison of successive academic achievements, reflecting the dynamics of learning process. That is, this model should be dynamic. Based on the analysis of pedagogical science data in the field of educational achievement modelling (Pustobaev and Saiapyn, 2005; Bespalko, 2002; Lerner, 1978; Raven, 1991; Babansky, 1989), a system of criteria has been proposed (Kolgatin, 2012) according to such components: motivation and target, educational content mastering, self-management and activity, reflection and prognosis (table 1). Further comprehensive developing of this model needs in a lot of experimental data on correspondence between criteria indicators that can be directly measured in educational process and real results of students' educational work. But we have not enough such data in modern publications as it was shown above.

Estimation of the parameters that characterise the educational content criteria is carried out by means of pedagogical testing based on the concept of the level of educational achievements in accordance with the works of Bespalko (Bespalko, 2002) and Lerner (Lerner, 1978) as well the Ukrainian educational standards. These works are not modern, but classic. The ideas of Bespalko correlate with Bloom's taxonomy (Bloom et al., 1956), but Bespalko's approach is more simple and useful for practical automated pedagogical measurements. Lerner's ideas give us possibility to classify criteria according to indicators than can be measured directly as it was shown in (Kolgatin, 2012).

The parameter of the lasting of knowledge has not included to composition of database for model parameters (Kolgatin, 2012). According to definition, lasting of knowledge is the permanent fixation in the student's memory of the system of essential knowledge and methods of their application or the willingness to derive the necessary knowledge from other based knowledge (Lerner, 1978). A natural measure of lasting of knowledge is the ratio of the appropriate mastering coefficients according to the preliminary and current testing. If the mathematical model used in the automated system of diagnostics considers the parameters of student's academic achievements in dynamics (as a function of time), then a separate parameter "lasting of knowledge" is not needed. It is replaced by the functional dependence of all other parameters on the time that, definitely, carries more information.

The parameters of the student's psychological and pedagogical characteristics are determined by the teacher on the basis of pedagogical observation and analysis of the products of the student's educational activity. The student also takes active part in determining these parameters by introspection.

A high level of reflection on the result of the activity indicate the student's ability to objectively evaluate own results of the learning activity and his desire to complete the task qualitatively, to bring the work to a logical conclusion. The presence of an appropriate parameter in the student psychological and pedagogical model (SPPM) gives a reason to offer students, who have the developed reflection to the result of own activity, educational tasks of a creative nature. Otherwise, such tasks as projects, creative works etc. can be ineffective without student's own reflection, because it is difficult to build an objective and unambiguous algorithm for its checking.

High importance of the result of learning activity for the student is expressed in the desire to master given knowledge and skills as soon as possible, to get the result of the activity in the form of a fully completed task or project, a solved problem, etc. Of great importance is the student's sense of satisfaction from the successful completion of similar tasks in the past (Raven, 1991). The organization of education of such students should provide for certain stop points at which the student can feel the completion of the stage of work. It is advisable to prevent the unexpected additional tasks and complications.

High interest in the process of learning is often native for students with research abilities, who can unlimited improve a computer program or laboratory equipment, collect some data from the Internet and so on. Modern multimedia tools and intelligent learning systems help to increase delight of the learning process itself. But the interest in certain activities in the absence of significance of the learning result leads to a

Table 1: Structure of the student psychological and pedagogical model.

Component	Criteria
Motivation and target	Significance of the result of learning activity for the student
	Student's interest in the educational process, cognitive interest
	Conscious adherence to the educational discipline
Educational content mastering	Completeness of knowledge
	Promptness of knowledge
	Depth of knowledge
	Flexibility of knowledge
	Systematic of knowledge
	Automation of activity
Self-management and activity	Stability of pace of learning activity
	Ability of the student to mobilize energy, persistence and will
Reflection and prognosis	Student's reflection on the result of activity
	Student's reflection on the process of activity

shift in the focus on minor things and reduce the effectiveness of learning. Such students need in regular diagnose of the structure of academic achievement and control the implementation of the curriculum. They need in systematicity of learning activity according to curriculum. Such systematicity can be achieved by direct management of student's independent work or by training the student in skills of self-management.

Cognitive interest as a separate parameter of the student model provides an opportunity to distinguish features of the student's motivation for learning activities. An important element of the emotional setting for learning activities is the conscious adherence to the educational discipline (Babansky, 1989), which is expressed in the self-control of the correspondence of the learning activity to the work plan and culture of interaction with other participants of the educational process (timely completion of tasks, conscious fulfilment of requirements, accuracy in visiting classes and appointed consultations).

The strength and stability of the student's concentration on learning activities in a particular discipline largely depends on the peculiarities of the mental processes and physiological properties of the student and determines the style of educational activity. Therefore, it is important to add to the student model (SPPM) a parameter that characterizes a student's ability to mobilize persistence and will (Raven, 1991), and a parameter that characterizes the stability of the pace of student's academic work (Babansky, 1989).

Activity of the student on introspection, observation of student's educational work, analysis of the style of educational achievements tests passing, analysis of the order of performance and presentation of educational products, analysis of the content of products of educational activity – are the sources of the information for the SPPM. It is advisable to measure parameters of reflection, emotional setting and volitional qualities on a scale of order (low, medium, high). The application of the equal-interval scale is problematic, because these parameters are complex and may include various indicators with significantly non-linear effect. Such measuring becomes a problem in case of lack of personal interconnection between student and teacher.

Summarising the above, it should be pointed that all indicators, which can be measured in some learning management system, are complex and are connected with several criteria of student's motivation, target of education, educational content mastering, self-management and activity, reflection and prognosis. We need to understand the main binds of each indicator with criteria. There will be studied the time of learning activity products submissions in this paper. We assume that in-time submission of student's works characterise student's motivation (criterion: Conscious adherence to the educational discipline), competency in self-managing (criteria: Stability of pace of learning activity; Ability of the student to mobilize energy, persistence and will) and reflection (criterion: Student's reflection on the process of activity). The time of submission can be directly analysed in Internet-oriented learning management systems, such as Moodle. We can see if the learning activity product was submitted in-time or not. We can also see the time of the submission. We can see if the student worked regular during a week or submitted the work in the last moment.

In this paper the systematicity of student's activity are understood in context of activity by the plan given by teacher or designed by student in accordance to curriculum. Correlations of systematicity indicators with parameters of student psychological and peda-

gogical model are analysed both hypothetical and experimental

3 SYSTEMATICITY OF STUDENTS LEARNING ACTIVITY IN BLENDED LEARNING

3.1 Methodology of Empirical Research

Study of features of students learning activity, connection between its systematicity and students' learning achievements was conducted in course "Operating Systems" with use of learning management system Moodle. Methods of learning the course "Operating Systems" are not a matter of this paper, but we should to describe the ground of our empirical work. In 2019 this course combines theoretical and practical issues of operating systems concepts, models of its interconnection with hardware, applied software and users (Tanenbaum and Bos, 2014; Allievi et al., 2022; Bacon and Harris, 2003). The first content module of this course is devoted to history and diversity of operating systems according to peculiarities its application. Students should understand the basic principles of computer hardware building, in particular, von Neumann principles, shared bus architecture, address space, function of the registers, interrupts etc. One of the main fundamental issues of this module is to show the deep connection between the hardware and operating systems architecture. The simple operations in operating systems with use of command interpreter and graphical user interface were also the object of students' educational activity. Second module is devoted to detailed study of main abstractions in the theory of the operating systems: virtual memory, processes and threads. Students used built in and third party software as well as the authors' models to investigate the peculiarities of internal mechanisms of multiprogramming realisation, especially of scheduling CPU time and access to slow devices as well as RAM memory access. The third module covers wide spectrum of practical issues of booting the operating systems and logical organisation of disk drives, file systems, the structure of executable files, mechanism of management of the Windows operating system, security in operating systems.

Practical component of students' educational activity was dominant. Students of second year, future bachelors of computer science and software engineering completed the practical tasks on analysing structure, functionality, principles of design of some operating systems with use of virtual machines. Special software for virtualisation was used for supporting educational activity on installing different operating systems and third party software. Methods of study operating systems with using of virtualisation are enough developed in modern pedagogical works. As an example we can suggest the research of Spirin and Holovnia (Spirin and Holovnia, 2018). The tasks that were suggested for students assumed a part of work to be done in classes and other part was homework. There was traditional educational process in 2019 with some components of student independent work management in Moodle. Personal Learning System in Moodle contained some theoretical materials, reference lists, instructions for the laboratory works. Personal Learning System was used by students to submit their reports on laboratory works completion.

Each student worked according to unique variant of the tasks, but some steps were very similar for all students. Each of these task contained both reproductive and creative steps with problem solving. There were suggested 11 tasks in 2019 year for every student for the semester according to the topics of the curricular:

- Analysing the ReactOS operating system (installing and customising the operating system, doing some work in it);
- Analysing the KolibriOS operating system (installing and customising the operating system, doing some work in it);
- Analysing the Ubuntu operating system (installing and customising the operating system, doing some work in it);
- Analysing active processes and threads in the Windows operating system (operating with processes and threads, obtaining the information about the active processes and threads using built-in and third-party software);
- Analysing CPU and memory managing procedure in the Windows operating system (simulating of the operating system scheduling with use of the special designed model WinMOS);
- Analysing the Windows virtual memory (getting the information and optimising RAM memory with use of built-in and third-party software);
- Analysing the structure of the Windows executable files (getting the information about files and its structure with use of the fields map and third-party software);
- Analysing the Registry in the Windows operating

system (using and changing the registry information for managing the operating system);

- Analysing system services and drivers in the Windows operating system;
- Analysing data security in the Windows operating system (working with accounts, encryption algorithms, digital signature);
- Analysing and optimising the Windows operating system booting.

As the result of this work, students prepared and submitted reports using Assignment activity in the university Personal Learning System based on Moodle. So, we have possibility to monitor the time of completing the task by the student. The grades for reports with late submission were less. The reports that were prepared later than 2 weeks after deadline were not accepted by personal learning system, and students presented such reports to teacher in printed form personally with oral discussion. These reports with very late submissions have not analysed in this paper. In total, 54 students took part in experiment. 274 reports were analysed. The final test in written form has been suggested to students for evaluating their educational achievements. The results of this test were the base for study the connection between systematicity of student's learning activity and his/her educational achievements.

3.2 Results and Discussion

Specific values of final test results were used for analysing correlation between systematicity of students' learning activity and their educational achievements (figure 1). This values were calculated as ratio of test result of each student to maximal test result. The indicator of systematicity was evaluated as a part of reports, submitted in time by a student, that is as a ratio of the number of reports, submitted by a student in time, to the number of reports according to plan (11 reports for 11 tasks). We believe that both these variables are measured on an interval scale, so Pearson correlation was used for analysis. The correlation between these two variables is 0.28 and is statistically significant at the significance level 5 % for samples size of 54 that is enough in pedagogical researches.

So, we can conclude that the part of reports, submitted by student in time, positively connected with educational achievements. What is the kind of this correlation? Three variants are possible: 1) systematic work according to the plan, given by the teacher, contributes for increasing educational achievements; 2) students with high initial educational achievements easily execute the tasks and submit their reports in time; 3) students with high competence in self-management of their independent work have high educational achievements at all and, in particular, use their skills to complete the tasks in time for higher grading. Both the first and the third variants correspond the positive influence of systematicity on educational achievements.

Analysing the diagram at figure 1, we can see that the second variant was not realised: students with high test results (above 60 %) had systematicity indicator from 0 to 100 % and there was not any trend. Moreover, there was not any student with very high (above 80 %) systematicity indicator and test results simultaneously. So, we can see that the student with highest educational results did not work according to common plan even losing some grades. They, may be, worked systematically, but according to their own plans, so methodology of our experiment did not give us possibility to measure peculiarities of this work. Otherwise, they may be characterised by low level of importance of the learning activity results and high interest in the process of learning, and high cognitive interest. It should be appropriate to use for such students not the direct management of their independent work, but co-management or self-management.

Analysing the lowest boundary of points allocation at figure 1, we can see that high value of the systematicity indicator (above 60 %) guaranteed sufficient educational results (above 40 %). But students with highest systematicity indicator did not show excellent results in testing. This analysis gives grounds for hypothesis that the kind of management of student's independent work should be timely turned from direct management through co-management and subsidiary management to self-management according to the level of student's educational achievements and skills in self-managing for increasing the efficiency of educational process.

Choosing the day for completing the report, students taken into account many tasks in various sides of their life and study. But the fact that the number of reports, submitted in the last day, exceeds in near four times the number of reports, submitted in any other day (see figure 2), show us the lack of students' competence in time planning and managing own work.

The deadline was set on Sunday at 11:55 PM. There was Saturday, free of classes. In some cases, students had more than a week to prepare their reports. But only 40 % reports were submitted in this period. Only 2 students used this period for stably work with every of their tasks. Our conclusion is to provide students with detailed direct management of their independent work at the initial stages of the course as well as to provide special training for in-

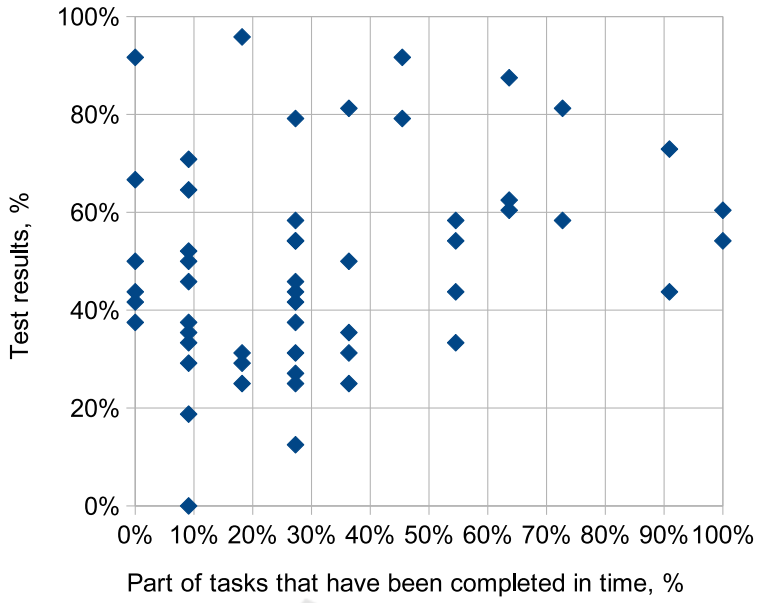

Figure 1: Correlation between systematicity of students' learning activity and their final assessment results at traditional blended learning process.

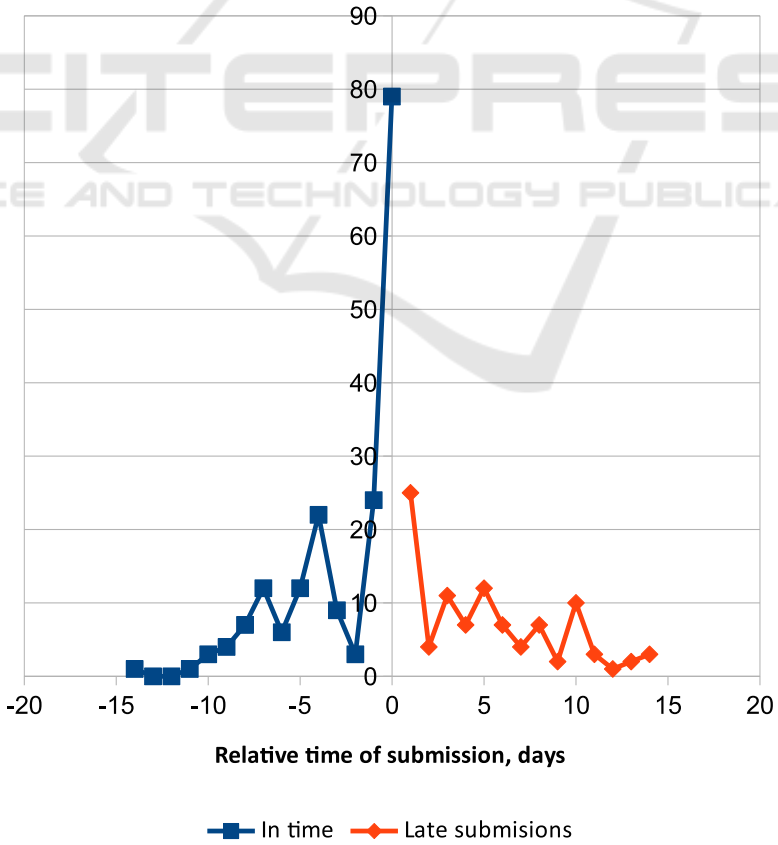

Figure 2: Frequency distribution of students' report submissions by days relatively from the official deadline.

creasing student's competence in time planning and self-management.

Did students work enough hardly in the educational process? Let us analyse diagram at figure 3. We can see that students work at any time of day and night accept of period from 4 AM to 7 AM. In our opinion, such time scheme does not promote the learning of deeper questions of educational material, does not support productive and creative learning activity. This is not a problem of one course or one university, but a complex goal of development the methodology of education in direction to turning from reproductive methods of learning to more efficient students' activity with active use the information and communication technologies in education. We should take into account dual educational process, which is coordinated with professional-oriented practice work.

4 SYSTEMATICITY OF STUDENTS LEARNING ACTIVITY IN DISTANCE LEARNING

4.1 Methodology of Empirical Research

COVID 2019 pandemic changed the educational process to mostly distance form of learning. So we could possibility to compare students behaviour in blended and full distance educational process. We continued to use the course "Operating Systems" and the Personal Learning System in Moodle as the base for our investigations. Participants of this work were future bachelors of software engineering both Ukrainian and foreign citizens. The language of study was English. The educational program was modified a little to shift accent on the student independent work. Theoretical and practical issues of operating systems concepts were studied in two content modules devoted to operating system concepts and administrating processes (table 2). There were suggested 8 laboratory work tasks to students (table 2), which assume solving practical problems on analysing structure, functionality and principles of design of some operating systems. The key attention was paid to Microsoft Windows operating system, because Linux solutions are the matter of additional course according to our educational program. These tasks were devoted to deep understanding fundamentals of operating systems and mastering skills of operating system administrating. Each of these task contained both reproductive and creative steps with problem solving. The tasks were suggested for students assumed all work to be done at home, but with online help of a teacher. The teacher was present online with using Zoom Cloud Meeting environment according to schedule. Each laboratory work was assisted by 2 academic hours of such online consultation and there were additional individual consultation in Zoom Cloud Meeting.

As the result of this work, students prepared and submitted reports using Assignment activity in the university Personal Learning System based on Moodle. The grades for reports with late submission were less. There were not hard deadline for submissions. Students had to presented all their reports to teacher online using Zoom Cloud Meeting environment with oral discussion. In total, 25 students took part in the course during 2020 and 2021 years under COVID-19 conditions. 147 reports were analysed. The final test has been suggested to students for evaluating their educational achievements using Moodle Assessment element. The results of this test were the base for study the correspondence between measured indicators and student educational achievements.

4.2 Results and Discussion

Values of final test results were used for analysing correlation between the part of reports submitted in-time by students and their educational achievements (figure 4). This values were calculated as ratio of test result of each student to maximal test result. The indicator of systematicity was evaluated as a part of reports, submitted in-time by a student, that is as a ratio of the number of reports, submitted by a student in-time, to the number of reports according to plan (8 reports for 8 tasks). Pearson correlation between these two variables is 0.67. This correlation is statistically significant at the significance level 0.1 % for samples size of 25.

We can conclude that the part of reports, submitted by student in time, positively connected with educational achievements.

Analysing the diagram in figure 4, we can see that despite the main tendency some students with high test results had systematicity indicator from 10 %. This results proves our previous hypothesis that some student with highest educational results did not work according to common plan even losing some grades. According to our pedagogical observations some of such students tried to complete the tasks earlier as soon as possible if they wanted to have highest grades. And distance learning process gave them such possibility, because all tasks were uploaded on Personal Learning System in Moodle environment. This situation ones more proves our conception that we need adaptively transform the mode of student independent

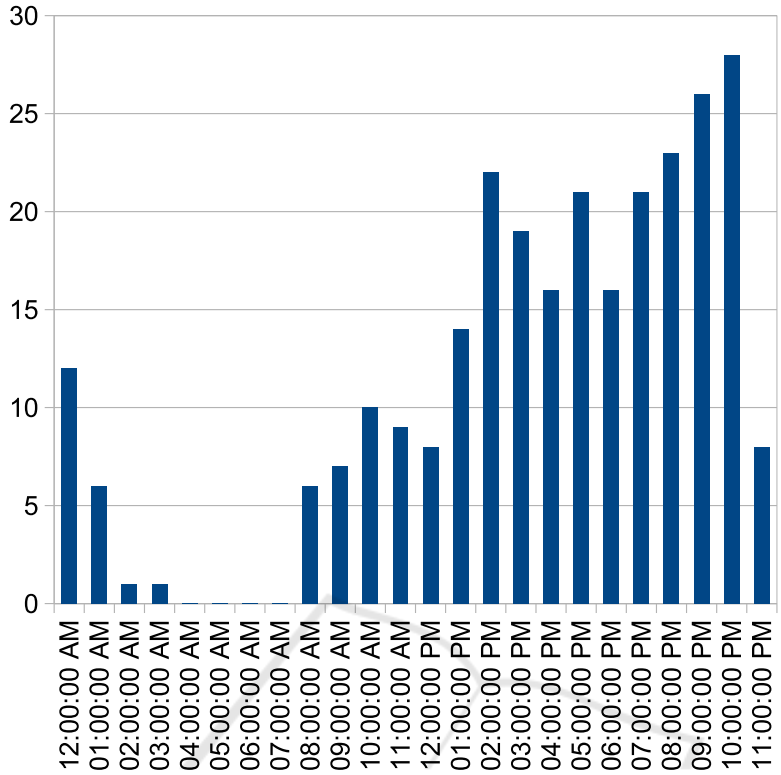

Figure 3: Frequency distribution of students' report submissions by time, summarising all days (Deadline was 11:55 PM).

work management from direct management through co-management and subsidiary management to self-management. We still can see that all students, who completed more than 50 % of the practical tasks in-time, had more than 50 % in test. So systematicity is the base obligatory requirement in educational process.

We see that the day before deadline is the most popular to complete the educational tasks, similar to traditional blended learning process (figure 5). Such behaviour require from student mobilizing energy, persistence and will. From the other side such behaviour can be the result of the lack of students' competence in time planning and managing own work.

The deadline was set at 11:55 PM in different days of a week. All students had more than a week to prepare their reports. But only 44 % reports were submitted in-time. We could not prove the statistical identity of student groups in 2019 and 2021 – 2022 years. There were different proportions of foreign and Ukrainian citizens in these samples, for example. So we can not make statistical comparison of relative time frequency distributions in blended and distance learning process. But analysing the diagram (figure 5) we can see more free students' time planning. There are some local maximums with a week (7 days) period before and after the deadline. The right tail (tasks that was not completed in-time) decreases slow. We believed that obtained new data confirm the conclusion to provide students with detailed direct management of their independent work at the initial stages of the course as well as to provide special training for increasing student's competence in time planning and self-management.

The distribution of students' working time has become more natural in distance learning process (figure 5). The most of reports were submitted in business time unlike the traditional blended learning.

The relative (on deadline) time of student's report submission can be used to build once more indicator – standard deviation of the submission relative time. We calculate the set of differences between the real time of each submission and deadline. After that we calculated the standard deviation for this set of values. Such an indicator take into account not the fact of in time submission, but evaluate stability of earlier and late submissions in comparison with our previous indicator ("Part of tasks that have been completed in time"). May be, some students have the own work schedule. They can submit the report 1 day later each

Table 2: Structure of the "Operating System" course in distance learning format.

Content Module	Theme	Laboratory Work Task
Operating System Concepts	Basic concepts, evolution, types of operating systems	Virtual Machine and Virtual Disks (creating virtual machine, installing and customising the operating system Kolibrios, doing some work in it)
	Architecture and resources of operating systems	Operating System Ubuntu: Basics of Administrating (installing and customising the operating system, doing some work in it, analysing resourses of the operating system using internal tools)
	Multitasking. Scheduling and interaction of processes and threads	Operating System Windows: Basics of Administrating. Task Manager (operating with processes and threads, obtaining the information about the active processes and threads using built-in and third-party software)
	RAM management	RAM and Virtual Memory (getting the information and optimising RAM memory with use of built-in and third-party software)
Operating System Administrating	Operating system booting. File systems	Operating System Booting. File Systems (getting the information about files and file system of different devices using internal Microsoft Windows tools and third party software, analysing and optimising the Windows operating system booting)
	System Registry in OS Windows	System Registry in OS Windows (using and changing the registry information for managing the operating system)
	Executable files. System services and drivers	Executable Files. System Services and Drivers (getting the information about executable files and its structure with use of the fields map and third-party software, analysing internal structure of driver initialisation files, managing system services using internal tools of Microsoft Windows operating system)
	Information security in operating systems	Information Security in Operating Systems (working with accounts, encryption algorithms, digital signature)

time, the stability of learning activity will be high and the value of "Standard deviation of the submission relative time" will be low. May be, some other student always submits the work in time, but does it 1 hour or 1 week randomly earlier. The stability of his learning work will be low, and the "Standard deviation of the submission relative time" indicator will be of high value. The suggested indicator can be useful in cases when the deadline is not hard but is only recommended by a teacher.

We apply this indicator only to students, who complete at least a half of the educational tasks, so the

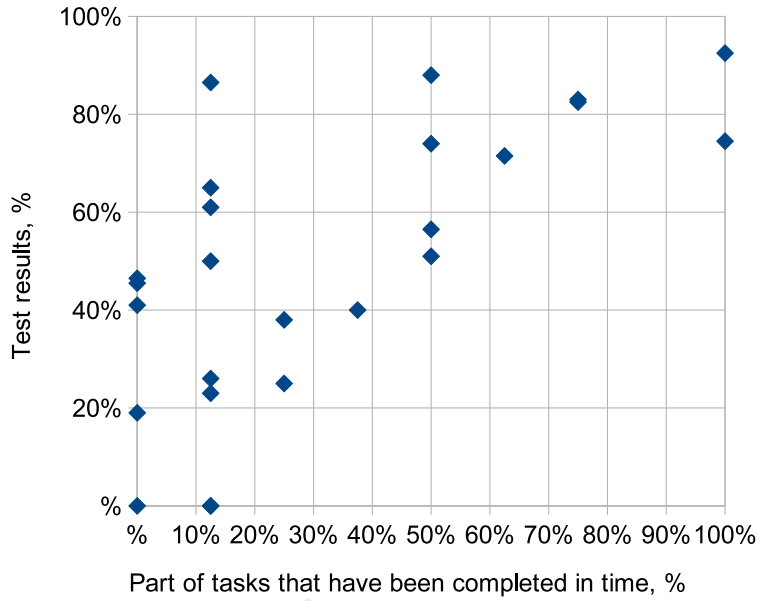

Figure 4: Correlation between systematicity of students' learning activity and their final assessment results at distance learning process under COVID-19 conditions.

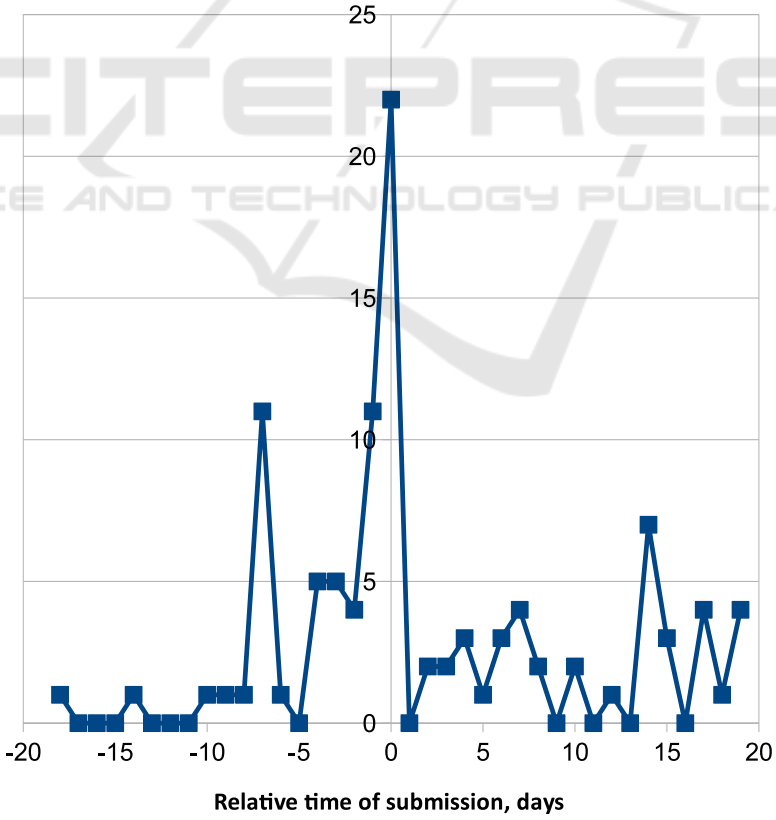

Figure 5: Frequency distribution of students' report submissions by days relatively from the official deadline (distance learning under the COVID-19 conditions).

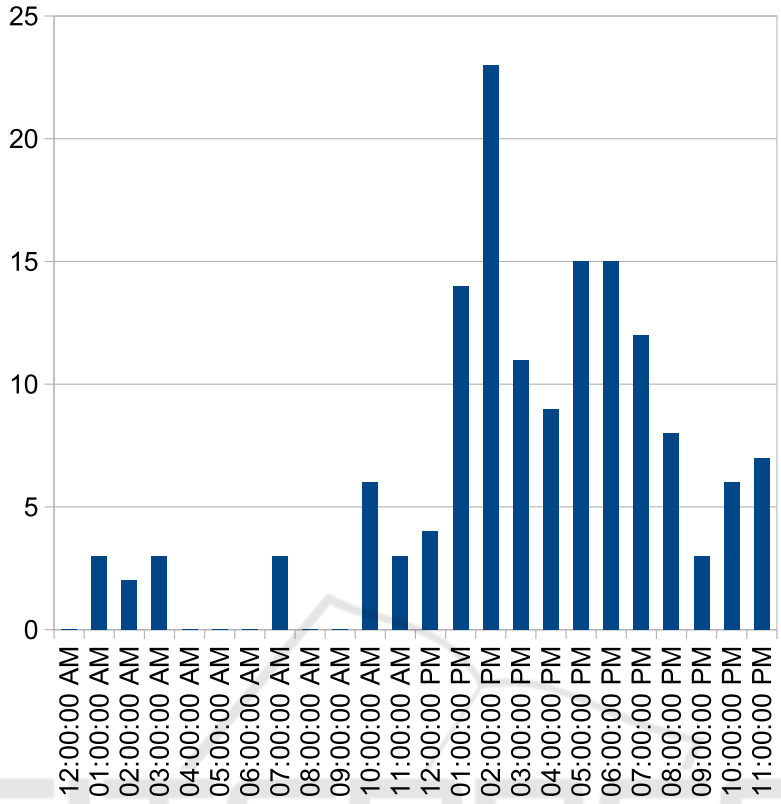

Figure 6: Frequency distribution of students' report submissions by time, summarising all days at distance learning under COVID-19 pandemic conditions (Deadline was 11:55 PM).

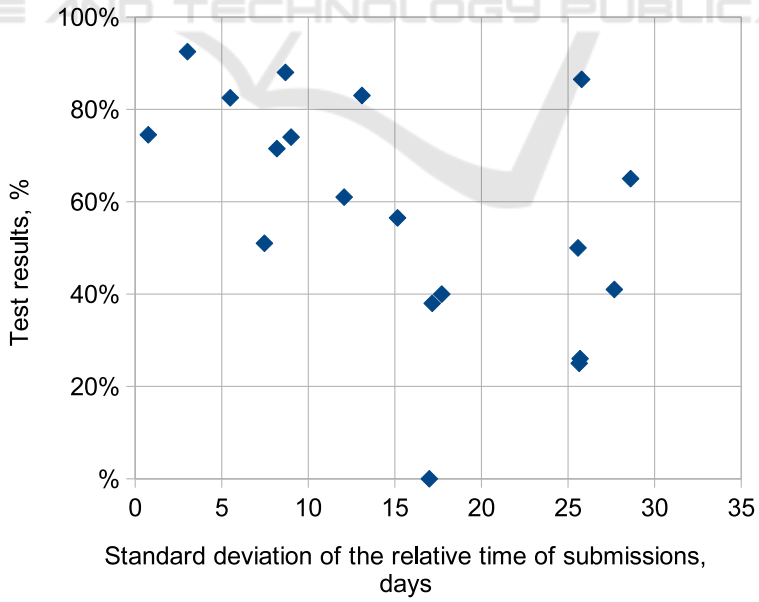

Figure 7: Correlation between standard deviation of the submission relative time and final assessment results of students at distance learning process under COVID-19 conditions.

sample size was 19. We assume that this indicator corresponds to such criteria of the student psychological and pedagogical model: stability of pace of learning activity, student's reflection on the process of activity. We can see negative correlation between this indicator and student's learning achievements (figure 7). The value of Pearson correlation is -0.51 and this correlation is significant at significance level 0.05 for the samples size 19. This result correlates with behaviour of our previous indicator – "Part of tasks that have been completed in time" figure 4. The standard deviation of relative (on deadline) time of student's report submission can be used as a prognosis parameter for student success in education.

5 CONCLUSIONS

Analysis of obtained experimental data in context of our theoretical framework has given the base for such conclusions:

- the ratio of educational tasks number completed in-time to its total number is an indicator that provide combined information about such criteria in student psychological and pedagogical model as 1) stability of pace of learning activity; 2) student's reflection on the process of activity; 3) conscious adherence to the educational discipline; 4) significance of the result of learning activity for the student. This indicator has good prognostic ability on the educational achievements;
- the analysis of relative to deadline time of students' learning product submissions give us information about 1) student's reflection on the process of activity; 2) ability to mobilize energy, persistence and will; 3) stability of learning activity pace;
- new data conform our previous conclusion that students' competency in self-management and time planning should be improved by providing students with detailed direct management of their independent work at the initial stages of the course as well as to provide special training for increasing student's competence in time planning and self-management;
- the mode of student's independent work management should be timely turned from direct management through co-management and subsidiary management to self-management according to the level of student's educational achievements and skills in self-managing for providing the efficiency of educational process at highest level of educational achievements.

This study does not exhaust all the aspects in the field of creating of comprehensive student model for the systems of pedagogical diagnostics and prognosis. The main task in this direction is in obtaining a lot of experimental data about corresponding of some educational process indicators and efficiency of one or another methods of learning. We also need to develop algorithms for estimating given criteria using available indicators.

Concerning further development of the course "Operating Systems" we plan to introduce the management of student's independent work with more or less elements of self-management according to the features and educational achievements of a student.

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